

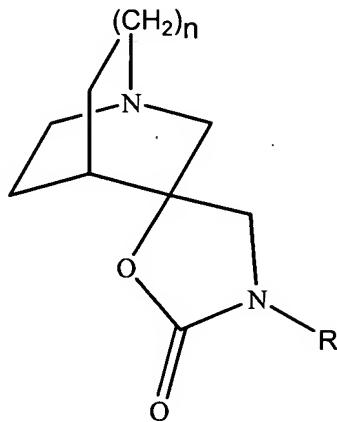
CLAIMS

What is claimed is:

1. A method of treating a patient suffering from a condition mediated by release of
5 a proinflammatory cytokine comprising
treating said patient with a cholinergic agonist selective for an $\alpha 7$ nicotinic receptor in an amount sufficient to decrease the amount of the proinflammatory cytokine that is released from a macrophage
wherein said condition is selected from the group consisting of
10 appendicitis, peptic, gastric and duodenal ulcers, peritonitis, pancreatitis, epiglottitis, achalasia, cholangitis, cholecystitis, hepatitis, Whipple's disease, asthma, allergy, anaphylactic shock, immune complex disease, organ ischemia, reperfusion injury, organ necrosis, hay fever, sepsis, septicemia, endotoxic shock, cachexia, hyperpyrexia, eosinophilic granuloma, granulomatosis, sarcoidosis, septic abortion, epididymitis, vaginitis, prostatitis, urethritis, bronchitis, emphysema, rhinitis, cystic fibrosis, pneumonitis, pneumoultramicroscopic silicovolcanoconiosis, alvealitis, bronchiolitis, pharyngitis, pleurisy, sinusitis, influenza, respiratory syncytial virus infection, herpes infection, HIV infection, hepatitis B virus infection, hepatitis C virus infection, disseminated bacteremia, Dengue fever, candidiasis, malaria, filariasis, amebiasis, hydatid cysts, burns, vasulitis, angiitis, endocarditis, arteritis, atherosclerosis, thrombophlebitis, pericarditis, myocarditis, myocardial ischemia, periarteritis nodosa, rheumatic fever, coeliac disease, congestive heart failure, adult respiratory distress syndrome, chronic obstructive pulmonary disease, meningitis, encephalitis, neuritis, neuralgia, spinal cord injury, 15 paralysis, uveitis, arthritides, arthralgias, osteomyelitis, fasciitis, Paget's disease, gout, periodontal disease, rheumatoid arthritis, synovitis, myasthenia gravis, thryoiditis, systemic lupus erythematosus, Goodpasture's syndrome, Behcets's syndrome, allograft rejection, graft-versus-host disease, ankylosing spondylitis,
20
25

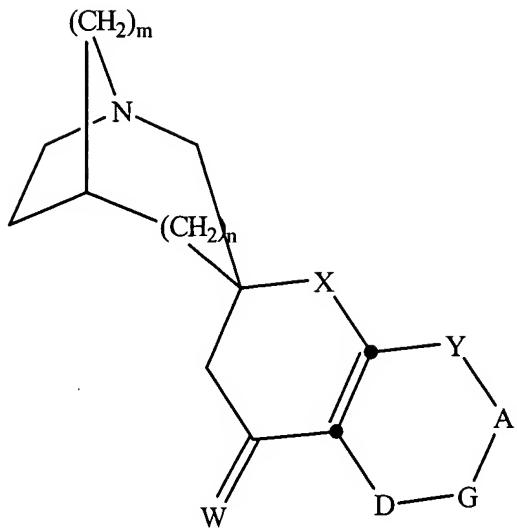
Berger's disease, ankylosing spondylitis, Berger's disease, Retier's syndrome, and Hodgkins disease.

2. The method of claim 1, wherein the proinflammatory cytokine is selected from the group consisting of tumor necrosis factor (TNF), interleukin (IL)-1 β , IL-6, IL-18 and HMG-1.
- 5 3. The method of claim 1, wherein the proinflammatory cytokine is TNF.
- 10 4. The method of claim 1, wherein the cholinergic agonist is selected from the group consisting of a quaternary analog of cocaine; (1-aza-bicyclo[2.2.2]oct-3-yl)-carbamic acid 1-(2-fluorophenyl)-ethyl ester; a compound of formula I:



I

- 15 1. wherein, R represents hydrogen or methyl, and n represents 0 or 1; a pharmaceutically acceptable salt of a compound of formula I; a compound of formula II:



II

wherein:

m is 1 or 2,

n is 0 or 1,

Y is CH, N or NO,

5 X is oxygen or sulfur,

W is oxygen, H₂ or F₂,A is N or C(R²),G is N or C(R³),D is N or C(R⁴),

10 with the proviso that no more than one of A, G and D is nitrogen but at least one of Y, A, G and D is nitrogen or NO,

R¹ is hydrogen or C₁-C₄ alkyl,R², R³ and R⁴ are independently hydrogen, halogen, C₁-C₄ alkyl, C₂-C₄ alkenyl,C₂-C₄ alkynyl, aryl, heteroaryl, OH, OC₁-C₄ alkyl, CO₂R₁, -CN, -NO₂, -NR₅R₆, -15 CF₃ or -OSO₂CF₃, or R² and R³, R³ and R⁴, respectively, may together form another six membered aromatic or heteroaromatic ring sharing A and G, or G and D, respectively, containing between zero and two nitrogen atoms, and substituted with one to two of the following substitutents: independently

hydrogen, halogen, C₁-C₄ alkyl, C₂-C₄ alkenyl, C₂-C₄ alkynyl, aryl, heteroaryl, OH, OC₁-C₄ alkyl, CO₂R¹, -CN, -NO₂, -NR⁵R⁶, -CF₃ or -OSO₂CF₃, R⁵ and R⁶ are independently hydrogen, C₁-C₄ alkyl, C(O)R⁷, C(O)NHR⁸, C(O)OR⁹, SO₂R¹⁰ or may together be (CH₂)_jQ(CH₂)_k where Q is O, S, NR¹¹, or a bond,

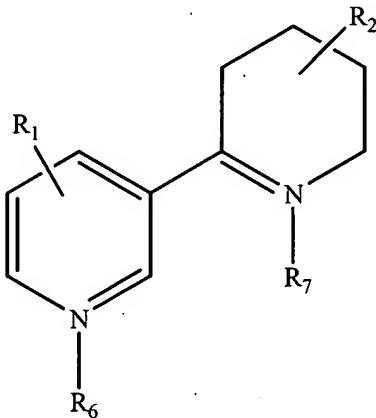
5

j is 2 to 7,

k is 0 to 2,

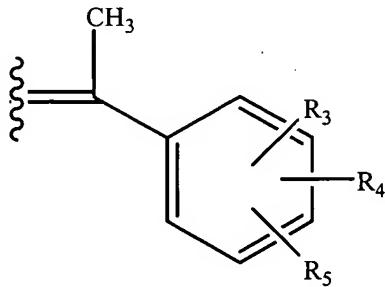
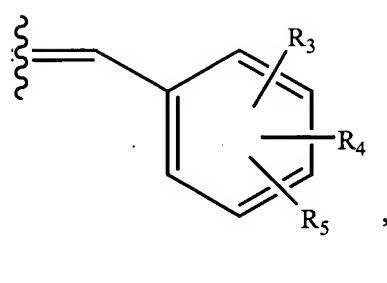
10

R⁷, R⁸, R⁹, R¹⁰ and R¹¹ are independently C₁-C₄ alkyl, aryl, or heteroaryl, or an enantiomer thereof; a pharmaceutically acceptable salt of a compound of formula II; a compound of formula III:

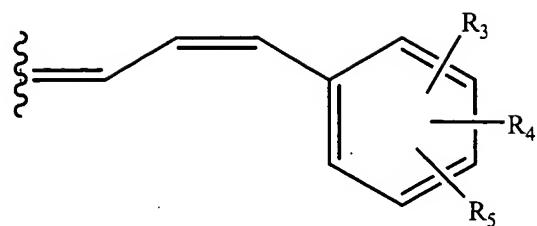


III

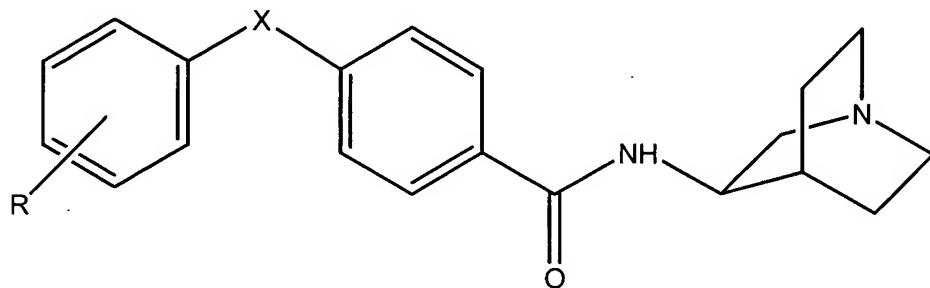
wherein R₁, R₆ and R₇ are hydrogen or C₁-C₄ alkyl, and R₂ is selected from a group of



and



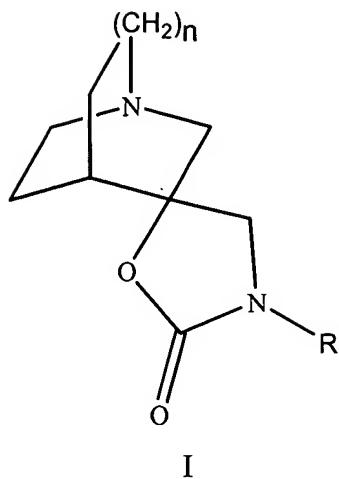
wherein, R₃, R₄ and R₅ are selected from the group consisting of hydrogen, C₁-C₄ alkyl optionally substituted with N,N-dialkylamino having 1 to 4 carbons in each of the alkyls, C₁-C₆ alkoxy optionally substituted with N,N-dialkylamino having 1 to 4 carbons in each of the alkyls, carboalkoxy having 1 to 4 carbons in the alkoxy, amino, amido having 1 to 4 carbons in the acyl, cyano, and N,N-dialkylamino having 1 to 4 carbons in each of the alkyls, halo, hydroxyl or nitro; and a compound of formula IV:



IV

wherein X is O or S, and R is selected from the group consisting of H, OR₁, NHC(O)R₁, and a halogen, wherein R₁ is a C₁-C₄ alkyl.

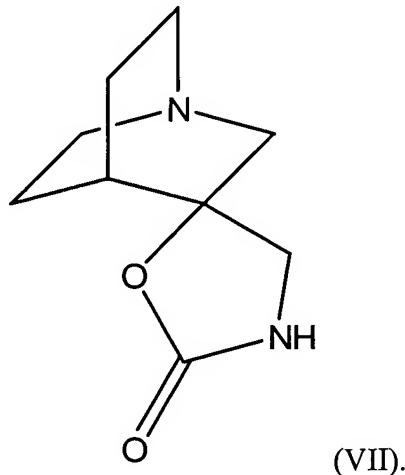
5. The method of claim 1, wherein the cholinergic agonist is a compound of formula I:



I

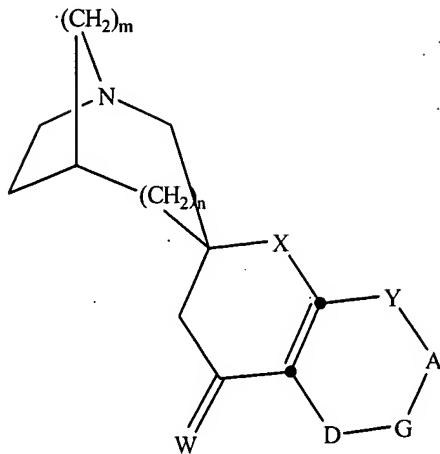
wherein, R represents hydrogen or methyl, and
 n represents 0 or 1;
 or a pharmaceutically acceptable salt thereof.

5 6. The method of claim 5, wherein the cholinergic agonist is (-)-spiro[1-azabicyclo[2.2.2]octane-3,5'-oxazolidin-2'-one]



(VII).

7. The method of claim 1, wherein the cholinergic agonist is a compound of formula II:



II

wherein:

m is 1 or 2;

n is 0 or 1;

Y is CH, N or NO;

5 X is oxygen or sulfur;

W is oxygen, H₂ or F₂;

A is N or C(R²);

G is N or C(R³);

D is N or C(R⁴);

10 with the proviso that no more than one of A, G and D is nitrogen but at least one of Y, A, G and D is nitrogen or NO;

R¹ is hydrogen or C₁-C₄ alkyl;

15 R², R³ and R⁴ are independently hydrogen, halogen, C₁-C₄ alkyl, C₂-C₄ alkenyl, C₂-C₄ alkynyl, aryl, heteroaryl, OH, OC₁-C₄ alkyl, CO₂R₁, -CN, -NO₂, -NR₅R₆, -CF₃ or -OSO₂CF₃, or R² and R³, R³ and R⁴, respectively, may together form another six membered aromatic or heteroaromatic ring sharing A and G, or G and D, respectively, containing between zero and two nitrogen atoms, and substituted with one to two of the following substitutents: independently

hydrogen, halogen, C₁-C₄ alkyl, C₂-C₄ alkenyl, C₂-C₄ alkynyl, aryl, heteroaryl, OH, OC₁-C₄ alkyl, CO₂R¹, -CN, -NO₂, -NR⁵R⁶, -CF₃ or -OSO₂CF₃;

R^5 and R^6 are independently hydrogen, C_1 - C_4 alkyl, $C(O)R^7$, $C(O)NHR^8$, $C(O)OR^9$, SO_2R^{10} or may together be $(CH_2)_jQ(CH_2)_k$ where Q is O, S, NR^{11} , or a bond;

5

j is 2 to 7;

k is 0 to 2;

R^7 , R^8 , R^9 , R^{10} and R^{11} are independently C_1 - C_4 alkyl, aryl, or heteroaryl, or an enantiomer thereof.

10 or a pharmaceutically acceptable salts thereof.

8. The method of claim 7, wherein the cholinergic agonist is a compound of formula II wherein m is 1; n is 0; p is 0; x is oxygen; A is C(R²); G is C(R³); and D is C(R⁴).

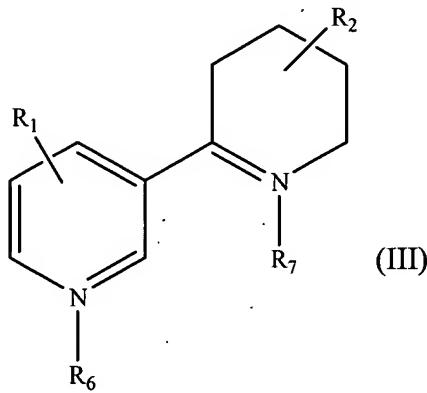
15

9. The method of claim 7, wherein the cholinergic agonist is 5'-phenylspiro[1-azabicyclo[2.2.2]octane-3,2'-(3'H)-furo[2,3-b]pyridin].

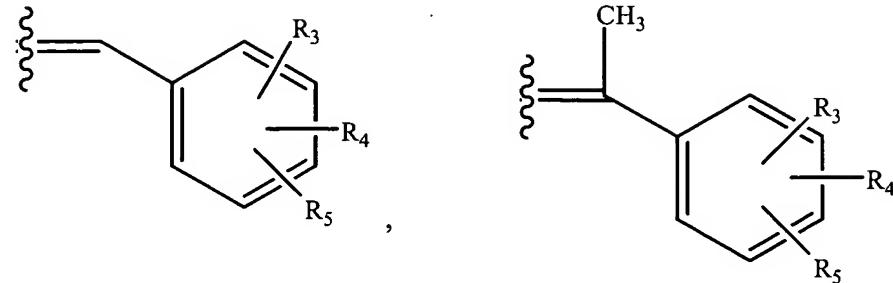
10. The method of claim 1, wherein the cholinergic agonist is a compound of formula III:

30

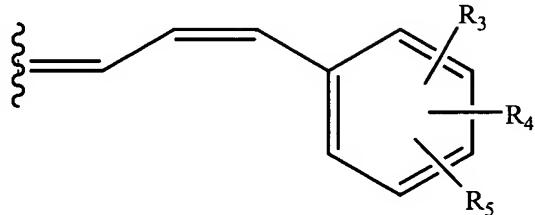
10. The method of claim 1, wherein the cholinergic agonist is a compound of formula III:



wherein R₁, R₆ and R₇ are hydrogen or C₁-C₄ alkyl; and R₂ is selected from a group of



and



wherein, R₃, R₄ and R₅ are selected from the group consisting of hydrogen, C₁-C₄ alkyl optionally substituted with N,N-dialkylamino having 1 to 4 carbons in each of the alkyls, C₁-C₆ alkoxy optionally substituted with N,N-dialkylamino having 1 to 4 carbons in each of the alkyls, carboalkoxy having 1 to 4 carbons in the alkoxy, amino, amido having 1 to 4 carbons in the acyl, cyano, and N,N-dialkylamino having 1 to 4 carbons in each of the alkyls, halo, hydroxyl or nitro.

10 11. The method of claim 10, wherein the cholinergic agonist is a compound of formula III, wherein R₂ is attached to the 3-position of the tetrahydropyridine ring, and further wherein R₃, which is attached to the 4- or the 2- position of the phenyl ring, is selected from the group consisting of amino, hydroxyl, chloro, cyano, dimethylamino, methyl, methoxy, acetylamino, acetoxy, and nitro.

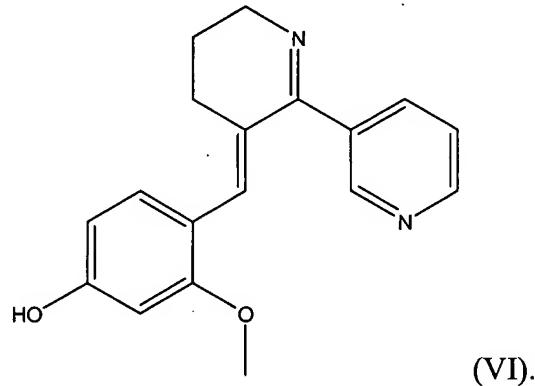
15

12. The method of claim 10, wherein the cholinergic agonist is a compound selected from the group consisting of formula III, wherein R₃ is hydroxyl, and wherein R₁, R₄, and R₅ are hydrogen; formula III, wherein R₃ is acetylamino and wherein R₁, R₄, and R₅ are hydrogen; formula III, wherein R₃ is acetoxy and wherein R₁,

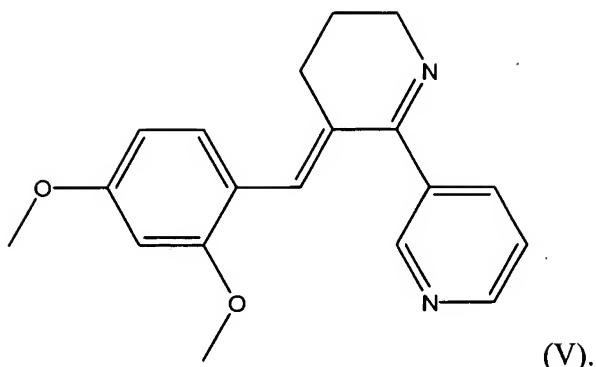
5 R₄, and R₅ are hydrogen; formula III, wherein R₃ is methoxy, and wherein R₁, R₄, and R₅ are hydrogen; formula III, wherein R₃ is methoxy and wherein R₁ and R₄ are hydrogen, and further wherein R₃ is attached to the 2-position of the phenyl ring, and R₅, which is attached to the 4-position of the phenyl ring, is methoxy or hydroxy.

10 13. The method of claim 10, wherein the cholinergic agonist is selected from the group consisting of 3-2,4-dimethoxybenzylidene anabaseine (DMXB-A), 3-(4-hydroxybenzylidene)anabaseine, 3-(4-methoxybenzylidene)anabaseine, 3-(4-aminobenzylidene)anabaseine, 3-(4-hydroxy-2-methoxybenzylidene)anabaseine, 3-(4-methoxy-2-hydroxybenzylidene)anabaseine, trans-3-cinnamylidene anabaseine, trans-3-(2-methoxy-cinnamylidene)anabaseine and trans-3-(4-methoxycinnamylidene)anabaseine.

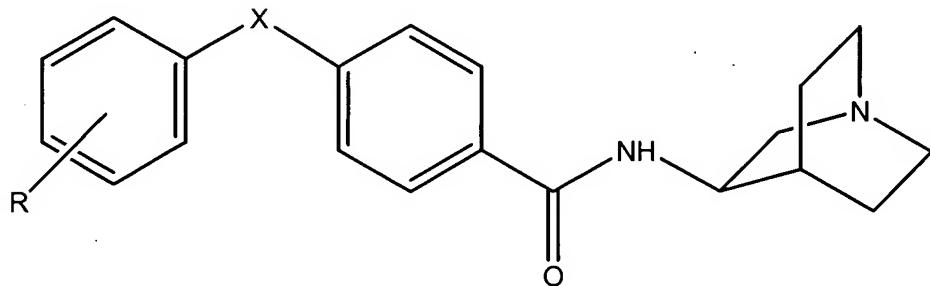
15 14. The method of claim 10, wherein the cholinergic agonist is 3-(4-hydroxy-2-methoxybenzylidene)anabasine



15. The method of claim 10, wherein the cholinergic agonist is 3-(2,4-dimethoxybenzylidene)anabaseine.



16. The method of claim 1, wherein the cholinergic agonist is a compound of formula IV:



IV

wherein X is O or S; and

5 R is selected from the group consisting of H, OR₁, NHC(O)R₁, and a halogen, wherein R₁ is a C₁-C₄ alkyl.

17. The method of claim 15, wherein the cholinergic agonist is selected from a group consisting of N-[(3R)-1-azabicyclo[2.2.2]oct-3-yl]-4-(4-hydroxyphenoxy)benzamide, N-[(3R)-1-azabicyclo[2.2.2]oct-3-yl]-4-(4-acetamidophenoxy)benzamide, N-[(3R)-1-azabicyclo[2.2.2]oct-3-yl]-4-(phenylsulfanyl)benzamide, and N-[(3R)-1-azabicyclo[2.2.2]oct-3-yl]-4-(3-chlorophenylsulphonyl)benzamide.

18. The method of claim 15, wherein the cholinergic agonist is N-[(3R)-1-azabicyclo[2.2.2]oct-3-yl]-4-(phenylsulfanyl)benzamide.
- 5 19. The method of claim 1, wherein the cholinergic agonist is cocaine methiodide.
20. The method of claim 1 wherein the condition is selected from the group consisting of appendicitis, peptic, gastric and duodenal ulcers, peritonitis, pancreatitis, hepatitis, asthma, allergy, anaphylactic shock, organ necrosis, hay fever, sepsis, septicemia, endotoxic shock, cachexia, septic abortion, disseminated bacteremia, burns, coeliac disease, congestive heart failure, adult respiratory distress syndrome, chronic obstructive pulmonary disease, rheumatoid arthritis, systemic lupus erythematosus, myocardial ischemia, spinal cord injury, paralysis, allograft rejection and graft-versus-host disease.
- 10 15 21. The method of claim 1 wherein the condition selected from the group consisting of appendicitis, peptic, gastric or duodenal ulcers, peritonitis, pancreatitis, hepatitis, asthma, allergy, anaphylactic shock, organ necrosis, hay fever, sepsis, septicemia, endotoxic shock, cachexia, septic abortion, disseminated bacteremia, burns, congestive heart failure, adult respiratory distress syndrome, chronic obstructive pulmonary disease, rheumatoid arthritis, systemic lupus erythematosus, myocardial ischemia, cerebral infarction, cerebral embolism, spinal cord injury, paralysis, allograft rejection or graft-versus-host disease.
- 20 25 22. The method of Claim 1 wherein the condition is selected from the group consisting of peritonitis, pancreatitis, sepsis, endotoxic shock, adult respiratory distress syndrome, chronic obstructive pulmonary disease, rheumatoid arthritis, systemic lupus erythematosus, myocardial ischemia, allograft rejection, asthma, graft-versus-host-disease, congestive heart failure and cystic fibrosis.

23. The method of claim 1, wherein the condition selected from the group consisting of peritonitis, pancreatitis, sepsis, endotoxic shock, cachexia, adult respiratory distress syndrome, chronic obstructive pulmonary disease, rheumatoid arthritis, systemic lupus erythematosus, myocardial ischemia, and allograft rejection.

5

24. The method of claim 1, wherein the condition is sepsis.

25. A method for determining whether a compound is a cholinergic agonist selective for an $\alpha 7$ nicotinic receptor, the method comprising

10 determining whether the compound inhibits release of a proinflammatory cytokine from a mammalian cell, and

determining whether the compound is a cholinergic agonist reactive with at least one nicotinic receptor that is not $\alpha 7$,

15 wherein a compound that inhibits the release of the proinflammatory cytokine from the mammalian cell, but is not a cholinergic agonist reactive with at least one nicotinic receptor that is not $\alpha 7$, is a cholinergic agonist selective for an $\alpha 7$ nicotinic receptor.

26. The method of claim 25, wherein the proinflammatory cytokine is selected from the group consisting of tumor necrosis factor (TNF), interleukin (IL)-1 β , IL-6, IL-18 and HMG-1.

27. The method of claim 25 wherein the proinflammatory cytokine is TNF.

25 28. The method of claim 25 wherein the mammalian cell is an immune cell.

29. The method of claim 25 wherein the mammalian cell is a macrophage.

30. The method of claim 25 further comprising treating the mammalian cell with an agent that stimulates a proinflammatory cytokine cascade.

31. The method of claim 30, wherein the agent is LPS.
32. The method of claim 25 wherein the determination of inhibition of proinflammatory cytokine release comprises measurement of mRNA of the proinflammatory cytokine.
5
33. The method of claim 25 wherein the determination of inhibition of proinflammatory cytokine release comprises measurement of the proinflammatory cytokine protein.
10
34. The method of claim 25 wherein the determination of inhibition of proinflammatory cytokine release comprises measurement of proinflammatory cytokine activity.
15
35. A method for determining whether a compound is a cholinergic antagonist reactive with an $\alpha 7$ nicotinic receptor, the method comprising determining whether the compound reduces the ability of a cholinergic agonist to inhibit the release of a proinflammatory cytokine from a mammalian cell,
20 wherein a compound that reduces the ability of a cholinergic agonist to inhibit the release of a proinflammatory cytokine from a mammalian cell is a cholinergic antagonist reactive with an $\alpha 7$ receptor.
36. The method of claim 35, wherein the proinflammatory cytokine is selected from the group consisting of tumor necrosis factor (TNF), interleukin (IL)-1 β , IL-6,
25 IL-18 and HMG-1.
37. The method of claim 35, wherein the proinflammatory cytokine is TNF.
- 30 38. The method of claim 35, wherein the mammalian cell is an immune cell.
38.

39. The method of claim 35, wherein the mammalian cell is a macrophage.
40. The method of claim 35, further comprising treating the mammalian cell with an agent that stimulates a proinflammatory cytokine cascade.
5
41. The method of claim 40, wherein the agent is LPS.
42. The method of claim 35, wherein the determination of whether the compound reduces the ability of the cholinergic agonist to inhibit the release of a proinflammatory cytokine from a mammalian cell comprises measurement of mRNA of the proinflammatory cytokine.
10
43. The method of claim 35, wherein the determination of whether the compound restrains the ability of the cholinergic agonist to inhibit the release of a proinflammatory cytokine from a mammalian cell comprises measurement of the proinflammatory cytokine protein.
15
44. The method of claim 35, wherein the determination of whether the compound restrains the ability of the cholinergic agonist to inhibit the release of a proinflammatory cytokine from a mammalian cell comprises measurement of proinflammatory cytokine activity.
20
45. A method for determining whether a test compound has the ability to inhibit inflammation, the method comprising determining whether the test compound is a cholinergic agonist reactive with an $\alpha 7$ nicotinic receptor.
25
46. The method of claim 45, wherein the receptor is on a macrophage.

47. A method for determining whether a test compound has the ability to inhibit inflammation, the method comprising determining whether the test compound inhibits binding of an antagonist to an $\alpha 7$ nicotinic receptor.
- 5 48. The method of claim 47, wherein the antagonist to an $\alpha 7$ receptor is bungarotoxin.
49. An oligonucleotide or mimetic capable of inhibiting attenuation of lipopolysaccharide-induced TNF release from a mammalian macrophage upon 10 exposure of the macrophage to a cholinergic agonist, wherein the oligonucleotide or mimetic consists essentially of a sequence greater than 5 nucleotides long that is complementary to an mRNA of an $\alpha 7$ receptor.
50. The oligonucleotide or mimetic of claim 49, wherein the sequence is 15 complementary to a transcription initiation region of the mRNA.
51. The oligonucleotide of claim 49, wherein the sequence comprises 5'-gcagcgcatgttgagtcccg-3'.
- 20 52. The oligonucleotide or mimetic of claim 49, wherein the sequence consists essentially of 5'-gcagcgcatgttgagtcccg-3'.
53. A method of inhibiting attenuation of TNF release from a mammalian 25 macrophage upon exposure of the macrophage to a cholinergic agonist, the method comprising treating the macrophage with the oligonucleotide or mimetic of claim 49.
54. The method of claim 53, wherein the macrophage is in a mammal.
- 30 55. The method of claim 54, wherein the mammal is a human.